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08 APR 2005

00531081

AIRCRAFT INSTRUMENT PANEL

The invention relates to instruments for aiding the piloting of aircraft. More precisely, it relates to the instruments on board aircraft whose piloting requires, for technical reasons or for regulatory reasons, the presence of standby instruments to display essential navigation data in the event that the main display systems fail.

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In a typical example, for a commercial aircraft transporting passengers, the aircraft instrument panel comprises amongst other things:

- 15 - a main display for displaying with great precision a horizon, an attitude of the aircraft, and altitude, heading and speed data; this display receives the information computed by a computer of the airplane based on data received from various sensors;
- 20 - a standby horizon, a standby altimeter, and a standby anemometer independent of the main system, for displaying in a more concise manner and with less precision a horizon, an altitude, a speed and where necessary some other data; the displayed information is computed by these independent instruments
- 25 themselves, the latter receiving signals from sensors less sophisticated than those that are used for the main display; the standby horizon, the standby altimeter and the standby anemometer may be grouped together in an "integrated electronics standby
- 30 instrument" which displays all the standby information on one and the same color screen. The sensors associated with the integrated electronics standby instrument may or may not be integrated into this instrument; if the primary display system fails,
- 35 the pilot uses the data from the standby instruments.

The main display system is duplicated when the cockpit comprises a pilot station and a copilot station. The primary displays are duplicated but the standby instrument is not usually duplicated. It is placed on

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the pilot side.

Furthermore, aircraft intended to fly long distances may also have an automatic pilot system, and the instrument panel then comprises an item of equipment for automatic pilot control. This item of equipment comprises manual control buttons that the pilot actuates to set a desired heading, a desired altitude, a desired speed, and a desired climb or descent gradient (or instead of a desired gradient, a desired vertical climb or descent speed, which amounts to the same thing). The control buttons are used to actuate angle coders whose logic signals are processed in the control station to allow the generation of control signals representing the set points chosen by the pilot. These signals are sent to the automatic pilot computer which controls the trajectory of the aircraft. At the same time, these control signals are used in the control station itself to display therein, for the attention of the pilot or pilots, the set point values chosen manually by means of the control buttons.

Finally, in large sized commercial airplanes, for safety reasons, provision is made for all the electronics and the software for operating the automatic pilot computer to be duplicated; thus, if a failure occurs in one hardware or software element of a computing channel, the other channel can take over. The computer therefore comprises two computing channels (including two channels in the electronic elements of the automatic pilot control panel on the instrument panel), and a check of one of the channels by the other to constantly verify that there is no divergence in the processing carried out by the two channels.

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The whole instrument panel is particularly costly when all the abovementioned requirements or even simply some of them must be satisfied. One aim of the invention is to make the instrument panel less costly.

According to the invention, the proposal is for an instrument panel which, in addition to a main display system for horizon and necessary piloting parameters, comprises two items of equipment identical from the point of view of hardware and the point of view of software, which are each provided with a display screen, automatic pilot control means (particularly buttons for adjusting set points given by the pilot), computing means and standby data (standby horizon, standby altitude, standby speed in principle) and means of displaying these data on the display screen.

In normal operating conditions, one of the items of equipment is configured in an "automatic pilot set point display" mode; its control buttons are then used to give the set points to the automatic pilot computer, and the set points are displayed on the screen. The other item of equipment is configured in "integrated standby data display" mode. It displays on the screen the standby horizon, the standby speed and the standby altitude which it computes based on signals supplied by sensors; the sensors, preferably, are not part of the equipment; they are outside the equipment and they supply their measurement signals simultaneously to the two items of equipment.

Since the items of equipment are identical, the production cost is lower. Furthermore, since the two items of equipment are identical, they can be used to satisfy the requirement for the presence of a dual computing channel for the automatic pilot. The equipment that displays the standby data has the computing software used for the "automatic pilot set point display" mode and this software runs, but without displaying the automatic pilot set points, even when the equipment is in "standby data display" mode. It receives the set points from the other item of equipment and processes them in order to send them

independently of the other item of equipment to the automatic pilot computer.

5 In operating conditions in which one of the two items of equipment has failed, the other automatically configures itself in "automatic pilot set point display" mode. As a variant, since the two items of equipment have all that is necessary to display the standby data, the item of equipment that has not failed
10 may display the automatic pilot data on one half of the screen and the standby data on the other. This is a degraded display mode, but is acceptable because it would be used only in case of failure.

15 Finally, in the event of dual piloting, with a pilot and a copilot, the display systems being placed between the pilot and the copilot, provision is preferably made for a switchover control button to be present on each of the items of equipment to invert the working modes
20 of the two items of equipment depending on the person who has the helm: the pilot on the left will in principle require the equipment closest to him to be in piloting set point display mode and the equipment furthest from him to be in standby data display mode.
25 When the copilot on the right takes the helm, he inverts the modes in order to require the equipment closest to him to be in automatic pilot set point display mode.

30 In summary, the invention proposes an aircraft instrument panel comprising on the one hand at least one main display system for horizon and necessary piloting parameters, and on the other hand an item of automatic pilot control equipment, which comprises
35 manual piloting set point control buttons and finally an item of standby display equipment allowing the display, independently of the main display system, of integrated standby data including a standby horizon, characterized in that the automatic pilot control

equipment and the standby display equipment are two identical items of equipment from the hardware point of view and the software point of view and each comprises a display screen capable of displaying the integrated standby data, and in that the two items of equipment have at least two operating modes, one of the modes being an integrated standby data display mode and the other being a mode of displaying the automatic pilot set points given by the pilot, the items of equipment each operating in a different mode in normal operating conditions.

The set points given by the pilot are entered via control buttons on the equipment that is in set point display mode. Preferably, these set points are sent at the same time to the two items of equipment, which process them in parallel to send the corresponding instructions, via two independent channels, to two independent computing systems of an automatic pilot computer with redundant computing channels.

The invention relates not only to an instrument panel thus constituted, but also to the integrated standby equipment itself, suitable for being installed on this instrument panel, the integrated standby equipment comprising both the hardware and the software capable of displaying on a single display screen either the standby data, including a standby horizon, when the equipment is operating in a standby data display mode, or automatic pilot set points when the equipment is operating in a piloting set point display mode, the equipment being provided with set point adjustment buttons.

Other features and advantages of the invention will appear on reading the following detailed description made with reference to the appended drawings in which:

- figure 1 represents an integrated standby instrument of the prior art;

- figure 2 represents an automatic pilot control panel of the prior art;
- figure 3 represents an instrument panel combining the elements of figures 1 and 2;
- 5 - figure 4 represents an instrument panel according to the invention;
- figure 5 represents in greater detail a possible configuration of the two identical items of equipment of the invention, when they are operating one in an automatic pilot set point display mode and the other
10 in a standby data display mode.

Figure 1 shows an integrated electronics standby instrument 10, which comprises a color screen 12 for
15 the display of a horizon 14 (ground in brown below, sky in blue above) and standby data necessary for piloting, that is mainly altitude (scrolling graduated scale 16 on the right), speed (scrolling graduated scale 18 on the left), and an airplane attitude symbol 20. The
20 horizon and data are displayed according to a computation made by the instrument based on signals originating from sensors some of which are outside the instrument and others of which may be inside or outside the instrument. The sensors are usually pressure
25 sensors (for the speed and for the altitude) and an inertia measurement unit for the attitude.

The instrument usually comprises an adjustment button 22 used to reset the atmospheric pressure according to
30 data communicated locally (for example supplied by the weather services close to an airport). It comprises other control buttons 24 serving various purposes (resetting the horizon, placing marks on the screen for authorized speed or altitude ranges, etc.). The
35 instrument comprises electronic circuits and onboard software. It supplies information independent of that which is given by the main aircraft navigation aid systems.

Figure 2 represents an automatic pilot control station 30. It essentially comprises buttons for adjusting set point values given by the pilot to an automatic pilot computer present in the aircraft. And it comprises
5 small screens for displaying the set point values entered, so that the pilot can check the action he takes on the buttons. For example, there are four set point buttons 32, 34, 36, 38 respectively for the aircraft speed, the heading and the track, the altitude
10 and the climb or descent gradient (pitch). And there are four corresponding displays 33, 35, 37, 39, each beside the corresponding set point button.

The other control buttons of the automatic pilot
15 control panel, numbered for example 40, 42, are automatic pilot engagement or disengagement buttons, piloting mode selection buttons, etc.

Figure 3 represents a passenger transport airplane
20 instrument panel, with pilot station and copilot station. The main display system comprises several piloting and navigation screens. For piloting, the horizon and piloting data are displayed on a screen 50 for the pilot and a screen 60 for the copilot. Other
25 screens 52, 54, for the pilot, 62, 64 for the copilot, and 70, 72 (for the pilot and copilot combined) supply other indications useful for piloting or navigation. The integrated electronics standby instrument 10 is placed on the pilot side. The automatic pilot control
30 panel 30 alone is placed above the array of piloting and navigation display systems. The pilot and copilot have access to the automatic pilot control panel which is in the center of the instrument panel in the upper portion of the latter. The automatic pilot set points
35 are handled as has been said on two independent computing channels but based on a single control panel.

Figure 4 represents an example of an instrument panel according to the invention. The main display systems,

for piloting as for navigation are conventional and may be identical to those of figure 3: screens 50, 52, 54, 60, 62, 64, 70, 72. The integrated electronics standby instrument is now placed beside the automatic pilot control panel, above these main display systems. And the standby instrument and the automatic pilot control panel now consist of two identical and interchangeable items of equipment, both from the hardware point of view and the software point of view, and they are coupled together to be able to operate together in a consistent manner. These two items of equipment, side by side, are indicated here by reference numbers 80 and 80'.

In normal operating mode of the aircraft (no failure of the aircraft's main display system, and no failure of one or other of the items of equipment 80 and 80'), each item of equipment may perform both of the types of tasks for which it is designed: tasks of computing standby data on the one hand to play the role of integrated electronics standby instrument and tasks of automatic piloting to play the role of automatic pilot control panel; but, with respect to the display on their respective screen, they operate at a given moment in two different modes and not in one and the same mode: one displays the computed standby data but does not display the automatic pilot set point indications; the other does not display the standby data but displays indications specific to the automatic pilot and in particular the set points that are given by the pilot or copilot.

A switchover control button 81, 81' on each of the items of equipment 80 and 80' is used to switch the operating mode of the items of equipment to invert the roles. The equipment that was in the "standby data display" mode switches to the "automatic pilot set point display" mode, and vice-versa, at the command of the button for changing the mode of one or other of the

items of equipment. This switchover is in practice carried out during a transition from piloting by the pilot (left seat of the airplane) to a piloting by the copilot (right seat), so that the person piloting has
5 on his side the automatic pilot data display (in normal operating conditions with no failure). The mode switchover button of one of the items of equipment therefore acts on the one hand to invert the mode of that item of equipment and on the other hand to send a
10 mode inversion signal to the other identical item of equipment.

The action on the set point control buttons of the equipment that is in piloting set point display mode
15 (for example equipment 80) causes this item of equipment to compute data for sending to the airplane automatic pilot computer, but also to display the set point data required by this action. And, simultaneously, the signals originating from the
20 control buttons of this item of equipment are transmitted to the other item of equipment (80'), which generates in the same manner signals for sending to the automatic pilot computer. The signals originating from the item of equipment 80 and 80', for sending to the
25 computer, may therefore be generated independently (irrespective of the action on the control buttons which is a unique action) and transmitted to two independent channels of the automatic pilot computer. This makes it possible to satisfy an automatic pilot
30 safety requirement, in the form of an independent processing by two distinct items of equipment when the two items of equipment display different information intended for the pilots.

35 If the main display systems fail, the pilot has the choice, via the display switchover control button, of placing close to him the standby data display or of keeping close to him the automatic pilot control display. In the landing approach phase, he will place

the standby data display close to him.

In the event of failure of one of the two items of equipment 80 and 80', the equipment that is still
5 operating will, as a matter of course, be placed in automatic pilot set point display mode, if it is not already in that mode, so that the pilot retains control of the piloting mode and that of the set points that he gives.

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It is assumed that the main display systems and an item of equipment 80 and 80' are not simultaneously failed, in which case the standby data would be lost. However, even in this case, the pilot may, in the landing phase
15 and after selecting manual pilot mode, switch back the item of equipment 80 or 80' that has not failed to the standby data display mode.

As a variant, if an item of equipment 80 or 80' fails, provision can be made for the item of equipment that has not failed to switch to a third display mode, which is a degraded mode, in which one portion of the screen displays the standby data and another portion displays the automatic pilot data.

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Figure 5 represents side by side the two items of equipment 80 and 80' according to the invention, in normal operating conditions, that is to say one displaying the automatic pilot data and the other
30 displaying the standby data and in particular the standby horizon.

The screen of the item of equipment 80 displays the same indications as the integrated electronics standby
35 instrument 10 of figure 1. The screen of the item of equipment 80' displays in particular the automatic pilot set points given by the pilot. These set points are displayed in a form different from that of the prior art since there are no longer any small

individual displays placed beside each set point adjustment button as was the case for example in figure 2. The set points are now displayed on a large screen which can for example be divided (in piloting set point display mode) into four zones 102, 104, 106, 108, 5 corresponding to four different set points. Each zone is close to a respective set point adjustment button 103, 105, 107, 109.

10 Amongst the control buttons of the item of equipment 80 or 80', there are therefore at least four piloting set point control buttons, respectively for the speed (top left), the heading (bottom left), the altitude (top right) and the vertical speed (bottom right). There is 15 also a rotating adjustment button 110, 110' which is used for resetting the local atmospheric pressure for the altimeter function present in standby data display mode. Various additional buttons, pushbuttons or switches, may be used, linked with the information 20 displayed by the software on the screen, to perform various functions similar to those of the integrated electronics standby instruments of the prior art (placing max or min speed marks for example) or to those of the automatic pilot control panels of the 25 prior art (selecting engagement or disengagement of the automatic pilot, selecting the automatic pilot mode, etc.). For the pilot, the functions of these buttons are defined by software in direct relation with the indications displayed on the screen, so that the same 30 buttons may be used for a number of different functionalities, including functionalities belonging to the two different modes of the equipment.

The set point adjustment control buttons are in any 35 case active (that is to say that they are executing a set point adjustment) only on the equipment that is in the piloting set point display mode. On the other item of equipment, they are inactive, that is to say that rotating them does not change the piloting set points.

They may however be active for another function linked to the standby data display, but this is not usually desirable for reasons of safety.

5 Thus, in the example described, preference has been given to providing on the equipment a specific button 110, 110' for resetting atmospheric pressure, even though in theory one of the set point adjustment buttons 103 to 109 could be used for this reset since
10 these buttons define no set point when the equipment is in standby data display mode. The specific button 110, 110' is not active for carrying out an atmospheric pressure reset unless the equipment is in standby data display mode.

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In the case of commercial passenger transport airplanes, thanks to the invention, the automatic pilot safety requirements are satisfied (10^{-6} failures per hour, a rate obtained thanks to redundancy) and those
20 of the standby functions (10^{-3} failures per hour), with a simplified instrument panel architecture.